HIGH RESOLUTION THERMOMETERS FOR GROUND AND SPACE APPLICATIONS

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High resolution thermometers with a resolution of 3x10-1 ^{0}K/√Hz had been flown on a space shuttle for the studies of phase transition of helium near the lambda point (2. 1768K). This resolution was found to be degraded by a factor of 2.5 in space due to random heating by cosmic rays. Here we give a report of our program to understand and improve the noise performance for ground applications and to minimize the cosmic ray effects for space applications,

The thermometer is based on DC magnetization measurements of a paramagnetic salt in a constant magnetic field using an RF-SQUID magnetometer. The salt material is chosen to have a Curie temperature near the lambda point for maximum sensitivity. The noise of the thermometer is caused by thermodynamic fluctuations of the energy between the salt and the superfluid helium which plays the role of a heat reservoir[1]. This picture is currently under further test by comparing the noise spectrum to the predictions of the fluctuation-dissipation theorem while several physical parameters arc changed. These parameters arc: the temperature, the salt material and the thermal resistance of the link between the salt and the reservoir. The noise characteristics of two different magnetic salts - $Cu(NH_4)_2Br_4 \cdot 2H_2O$ and $GdCl_3$ - with Curie temperatures of 1.8 K and 2.2 K, respectively, arc compared.

in space, the incidence of cosmic rays on the thermometer occurs at a rate of a few particles per second, Efforts arc current] y underway to reduce the thermal relaxation time of the thermometer to below 0.1 sec. The fast relaxation time combined with higher sampling rate would allow individual cosmic ray event to be resolved and rejected from the data stream. Recently wc also explore using pure aluminum instead of copper as structural and thermal material in the thermometer construction. Preparation is being made to compare the thermal relaxation times, Aluminum being less dense, has the advantage of lower scattering cross-section for cosmic rays.

[1] T. C. P. Chui, D. R. Swanson, M. J. Adriaans, J. A. Nissen and J. A. Lipa, Phys. Rev. Lett. 69,3005 (1 992).